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CONSTRUCTION FOR BUILDINGS PROTECTED AGAINST RADIATION

The invention relates to a construction with walls, ceilings, and/or floors as parts of the building, especially for buildings protected against radiation in which the parts of the building are made of reinforced concrete.

Buildings protected against radiation are necessary for example in the field of medicine with rooms in which radiation occurs, i.e. proton treatment rooms, that must be shielded so that the radiation cannot leave the treatment room. In a known design, extremely thick, solid, reinforced concrete walls are used for the rooms. Such a design is extremely expensive, and in addition, remodeling the building requires a great deal of effort.

In certain circumstances, remodeling is necessary since the proton treatment equipment has a limited service life and is usually leased because it is so expensive. The time at which the devices are dismantled and hence (in certain circumstances) the building is remodeled can be predicted.

The task of the present invention is therefore to create an economical construction, especially for radiation rooms, that meets the high demands of radiation screening and that may be remodeled economically if necessary.

The task is solved by the features of claim 1.

According to the invention, a building part of the construction is manufactured in a sandwich design. With its sandwich design, the building part has one layer of a material that protects against radiation and at least one layer of concrete. The

concrete layer primarily serves as a type of shell for holding the antiradiation material. In addition, if the concrete layer is correspondingly designed, the concrete layer can also help screen against radiation.

In a particularly preferred embodiment, the material that protects against radiation is on the side of the concrete layer facing away from the radiation room.

Water, especially bound water, has proven to be a particularly effective material to protect against radiation. To prevent moisture in the rooms, the water is bound to a solid material, and usually at least the same antiradiation effect arises as with unbound water.

It is particularly advantageous when the antiradiation material is natural, unfired calcium sulfate dihydrate. Calcium sulfate dihydrate is natural gypsum, and is particularly suitable as an antiradiation material because it binds water particularly well.

An easy and fast mode of assembly is to slide into a cavity antiradiation material made of gypsum panels that can be free-standing or mortared in. This type of construction is particularly advantageous for large, straight walls.

To make construction particularly easy, the antiradiation material is pourable hardened granular gypsum. Gypsum in this form is easy to manufacture, transport and process.

When the particle size of the gypsum granules is 40 mm and below, the granules can be easily and compactly poured into the provided cavities. Such a particle size can be economically manufactured.

The antiradiation material is advantageously compressed. This prevents undesirable cavities from arising in unfavorable circumstances that could impair the protection from radiation.

If the layer thickness of the antiradiation material is selected as a function of the radiation intensity to be screened, different radiation protection can be achieved with the same material.

It is advantageous when additives consisting of gibbsite, hydragillite, aluminum hydrate or magnesium sulfate are added to the antiradiation material. This can increase the protective effect.

When the antiradiation material is poured between a construction pit structure, in particular a sheet piling wall, and the concrete layer is poured in and possibly compressed, it achieves effective radiation protection for the environment, such as the groundwater.

It is particularly advantageous when the antiradiation material is between two layers of concrete. The antiradiation material can be easily and quickly set up, which makes building the construction faster and more economical.

If the concrete layer is made of a two-shell double wall, prefabricated concrete parts can be used for particularly fast and economical construction. The use of prefabricated concrete parts is particularly advantageous and an inventive embodiment of the invention.

Filling the double wall with site-mixed concrete produces a compact and heavy concrete layer that creates a wall which can undergo high static stress, and this additionally increases radiation protection.

It is particularly advantageous when heavy concrete with heavy media additives such as hematite, lead, steel or iron materials are used for the concrete layer and/or the site-mixed concrete to fill the double wall. Radiation protection is increased by iron additives that for example can be scrap iron granules.

If the building part consists of two spaced double walls and if the space between the two double walls is filled with antiradiation material, it is particularly economical to construct the radiation protection wall with a sandwich design. The double walls serve as permanent framework for the site-poured concrete that fills the gap between the two walls. The two double walls also serve as a permanent framework for the actual antiradiation material.

If the double walls are connected with tie rods running perpendicular to their lengthwise extension, the double walls are prevented from bulging when the antiradiation material is poured in, and the static strength of the double walls and concrete layer is increased.

The double wall is advantageously made of prefabricated concrete panels with essentially parallel, spaced walls. The individual walls are in particular connected with wall lattice girders. Such double walls are relatively easy to make and transport.

If the connecting elements for two double wall elements and/or one double wall element and a ceiling element are welded or screwed together, it produces a stable shell for pouring concrete into the cavity between the wall elements to yield a uniform, seamless concrete layer.

If the wall lattice girders between the wall elements are corrosion-resistant or are made of high-grade steel, impermissible corrosion and static weakness to the concrete layer are prevented.

To screen the construction from the earth, the construction is advantageously built of antiradiation material. This protects the groundwater from radiation.

Other advantages of the invention are described in the following exemplary embodiments.

Fig. 1 shows a plan of Construction according to the invention,

Fig. 2 shows a cross-section of a Construction according to the invention,

Fig. 3 shows a cross-section of a sandwich design according to the invention with double concrete walls.

The plan in Fig. 1 shows a construction (1) manufactured according to the invention. The construction (1) is surrounded by dirt (2) on three sides. An outer wall (3) of the construction (1) is at a distance from the dirt (2). A gypsum shell (4) is between the outer wall (3) and the dirt (2). The gypsum shell (4) is the antiradiation layer and provides the basic radiation protection of the construction (1) to the outside.

The gypsum material used for the gypsum shell (4) consists of natural, unfired calcium sulfate hydrate and is poured in the form of hardened, granulated gypsum between the outer wall (3) and the dirt (2), or a sheet pile wall installed during construction that retains the dirt (2). The sheet pile wall is removed after

the gypsum material is poured into the gap, and compressed if applicable. The gypsum shell (4) is given a specific thickness arising from the specific distance between the sheet pile wall and the outer wall (3) to provide a specific radiation protection for the environment. The construction (1) in which radiation is generated is therefore screened from the environment to prevent damage to the environment.

The outer wall (3) preferably consists of a concrete layer of heavy concrete that can contain iron additives to additionally provide radiation protection for the environment.

Another type of sandwich design is provided for the inner walls (5) of the construction (1). Two concrete layers (6) are provided at a distance from each other. Antiradiation material, preferably in the form of gypsum, is poured between the concrete layers (6). The granulated gypsum with a diameter less than 40 mm in a particularly preferable embodiment is poured into the gap between the two cement layers (6) and possibly compressed.

Alternately or additionally, gypsum panels can be installed instead of the granules. This can provide additional stability and in certain circumstances improve radiation protection. In some designs, the gypsum panels can be installed more quickly and economically.

The gypsum has a large amount of bound water and is therefore highly suitable as antiradiation material. The thickness of the gypsum or antiradiation layer can be selected as a function of the desired radiation protection. A thicker gypsum layer provides greater protection of neighboring rooms, and a thinner gypsum layer is sufficient when less screening is desired. Additives such as hydragillite,

aluminum hydrate or magnesium sulfate can be added to the gypsum (7) to improve radiation protection. However, this is only necessary if extremely high radiation protection is required. The concrete layer (6) can either be made of site-mixed concrete that can be heavy concrete with iron additives, or it can consist of the double walls as shown in Fig. 3.

Fig. 2 shows a section of a construction (1) according to the intention. The construction (1) is buried in the earth (2). In this case as well, the gypsum shell (4) also surrounds the building protecting it from the earth (2) and prevents the radiation generated in the construction (1) from entering the earth (2). This reliably prevents groundwater from being irradiated. The inner walls (5) of the construction (1) also consist of two concrete layers (6) and the gypsum (7) between them. A ceiling (8) lies on the concrete layers (6) and covers the top of the respective room of the construction (1).

To provide radiation protection for the interior in all directions, an additional gypsum ceiling (9) is above the ceiling (8). The gypsum ceiling (9) prevents radiation from exiting upward. The area above the gypsum ceiling (9) can be for normal uses such as a lawn or parking area.

To prevent an impermissible cavity from arising as a result of the gypsum (7) settling between the inner walls (5), the gypsum ceiling (9) is poured over the ceiling openings between the concrete layers (6). Material from the gypsum ceiling (9) will penetrate the gaps between the concrete layers (6) if the gypsum (7) between the concrete layers (6) actually settles. Settling can however be avoided if the gypsum (7) is compressed when it is poured to give it a lasting density.

The construction (1) is built on a floor slab (10) that rests on the gypsum shell (4). The gypsum shell (4) provides enough support to reliably hold the construction (1).

Fig. 3 shows a section of an inner wall (5) according to the invention that is made in a sandwich design. The inner wall (5) consists of two concrete layers (6) with gypsum (7) between them. The concrete layers (6) are made of double walls (1)1. Each double wall (11) consists of prefabricated concrete panels with essentially parallel, spaced walls (12).

The walls (12) are connected with a wall lattice girder (13) that can be made of corrosion resistant steel or high-grade steel. The wall lattice girders (13) hold the walls (12) at a distance from each other and enable fast construction. The walls (12) are erected and form a type of permanent framework between which site-mixed concrete (14) is poured. This produces a compact concrete layer (6). The two concrete layers (6) can be connected to each other with a tie rod (15) for static reinforcement to prevent the concrete layers (6) from bulging when the gypsum (7) is poured in. The tie rod (15) is advantageously connected to the inside walls of the double walls (11) and not to the outside walls (12) to prevent radiation from entering the environment via the tie rods (15).

Instead of site-mixed concrete (14), gypsum or other materials can be poured into the double wall (11). This creates a certain connection between neighboring double walls and also improves radiation protection. The double walls (11) can

either be connected by means of these fillers or by additional connecting means such as metal parts.

If several double walls (11) have to be joined to create the inner wall of the building, these double walls (11) can for example be welded at provided connecting sites to ensure a tight bond and prevent shifting while pouring the site-mixed concrete (14). When the double walls (11) are filled with site-mixed concrete (14), a seamless, uniform and continuous concrete layer (6) is obtained when several double walls (11) are used.

This invention is not limited to the portrayed exemplary embodiments. In particular, the sandwich design can be created using the two double walls (11) shown in Fig. 3, or a double wall (11) and a layer of site-mixed concrete, or a sheet wall, or simply the dirt surrounding the building. The concrete layers (6) can be filled with special concrete that provides a certain degree of radiation protection. The thickness of the gypsum layer (7) can depend on the radiation protection requirements. It can range from a few centimeters to several meters. The concrete layer (6) is normally approximately 3 cm thick. However, this thickness can vary depending on the radiation protection requirements or static requirements. Another suitable material can be used as the antiradiation layer in addition to the described gypsum, even though natural gypsum is held to be the most advantageous material at present since it is very economical. The thicknesses of the walls (12) of the double wall (11) can be the same or different. They can be made of conventional concrete or antiradiation concrete such as heavy concrete with iron additives.